YARROW, (H.C.)

Reptiles, poisonous.

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these two agents is probably the most extensive known. Muscarine is a powerful cardiac depressant. It causes salivation, lachrymation, as well as an increase in other glandular secretions, violent contractions of the gastric and intestinal muscles, with consequent vomiting and diarrhœa, contraction of the bladder, spleen, and uterus. It produces contraction of the pupil, and spasm of the accommodation. All these effects of muscarine rapidly disappear under the influence of atropine, and, further, they do not appear at all in an animal that is completely atropinized.

Muscarine causes death by cardiac paralysis. The fatal issue can be averted by the use of atropine.

4. *Atropine and Pilocarpine.* The antagonism existing between atropine and pilocarpine is very extensive, including almost the entire actions of these two agents. Pilocarpine causes an increase in all the secretions, especially of the secretion of the sweat and saliva. The salivation is due to irritation to the terminal filaments of the chorda tympani in the glands. It is rapidly arrested by atropine, and it can be prevented entirely by giving atropine previously.

The perspiration which is due to stimulation of the sudoriparous nerves and the sweat centres can also be prevented and arrested by the use of atropine. The other secretions are stimulated by pilocarpine, and arrested by atropine.

Pilocarpine contracts the pupil and gives rise to spasm of accommodation. Atropine dilates the pupil and causes paralysis of accommodation.

Pilocarpine slows and weakens the pulse, and lowers the blood-pressure. Atropine quickens and strengthens the pulse, and raises the blood-pressure. Atropine stimulates the respiratory centre. Pilocarpine has no definite effect on it.

Cases are recorded where pilocarpine has been used successfully in cases of poisoning by atropine, but it is doubtful whether the success was really dependent or not on the treatment. The power that pilocarpine has in antagonizing the effects of atropine is much less than the power of atropine over pilocarpine. When, further, we remember that in many cases of atropine-poisoning death results from a paralysis of the respiratory centre succeeding the over-stimulation first induced, it is not to be expected that much good will result from pilocarpine.

5. *Atropine and Morphine.* The antagonistic action between atropine and morphine is, in a practical point of view, the most important that we have to deal with. Cases of poisoning by opium and its alkaloid are very numerous, and owing to the alleged powerful antagonistic effects between it and atropine, numerous cases are on record in which this alleged power has been tested.

Atropine and morphine are antagonistic in their action on the pupil, the former causing dilatation, the latter contraction. In cases of poisoning by opium we do not always find the pupils contracted.

Morphine diminishes or arrests the peristaltic movements of the intestines, while atropine has a contrary effect. The functions of the heart are not greatly influenced by morphine; atropine, however, causes a marked increase in the number of beats. The effects on the respiratory centre are antagonistic. This is *the* important antagonistic action of these two agents. Morphine causes death by paralyzing the respiratory movements, while atropine stimulates the respiratory centre. In over-doses, however, this stimulating action may be followed by a depressing one. There is a general consensus of opinion in the profession that atropine is very efficient as a physiological antidote to opium-poisoning. Numerous cases are recorded where, apparently, death from an over-dose of opium or its alkaloid has been averted by the administration of atropine. The literature of this subject is now a very extensive one. Leukartz (*Deut. Arch. für klin. Med.*, Band 40, p. 574) gives a very complete *résumé* of the cases of opium treated by atropine. In all he has collected fifty-nine cases of opium-poisoning where atropine was used. In by far the greater number of these cases other measures were employed also. Artificial respiration, strong coffee, emetics, ammonia, alcohol, etc., were the principal adjuvants to the atropine treatment. Seventeen of the fifty-nine cases died, being a mortality of 28.8 per cent.

Leukartz believes that the essential effect of the opium—the coma—is increased rather than made less by the action of atropine; and further, that atropine is powerless in combating the great danger in opium-poisoning—the paralysis of the respiratory muscles. He has collected 73 cases of opium-poisoning in which atropine was not used in the treatment, and there were only 11 deaths, a mortality of fifteen per cent. We thus have a mortality of 28.8 per cent. in the cases where atropine was employed, and a mortality of fifteen per cent. where it was not used. Leukartz from his researches comes to the following conclusions:

1. That the alleged physiological antagonism between morphine and atropine has not one single certain observation for its foundation.
2. That in the treatment of morphine-poisoning by atropine no certain improvement is to be expected.
3. That the treatment of morphine-poisoning should be carried out rationally (artificial respiration, etc.), and not by the exhibition of an alleged physiological antagonist.
4. That statistics show that the former method is much to be preferred to the latter.

Leukartz's conclusions may appear rather startling to the many who have an unbounded faith in the value of atropine in opium-poisoning. Upon a close examination of them, however, they appear to be well grounded, being founded on facts. *James Stewart.*

RENNES-LES-BAINS is a spa in the Département de l'Aude, France, lying on the Salz River, at an elevation of 1,045 feet above the sea. There are five springs, the waters of which are administered both internally and externally. The springs are known respectively as the Bain Fort, Bain Doux, Bain de la Reine, Source du Pont, and Source du Cercle. The water of the Salz River, which contains the chlorides of sodium and magnesium, and the sulphates of sodium, calcium, and magnesium, is also used for drinking mixed with the spring waters. The following is the analysis of two of the springs, according to Ossian Henry (Dechambre's "Dictionnaire Encyclopédique"). In 1,000 parts there are of:

	Bain Fort.	Bain Doux.
Calcium carbonate	0.250	0.140
Magnesium carbonate	0.070	0.030
Sodium chloride	0.071	0.181
Magnesium chloride	0.280	0.244
Potassium chloride	trace	trace
Sodium sulphate	0.090	0.120
Calcium sulphate	0.162	0.180
Ferrous carbonate	0.031	0.002
Silicic acid, organic matters, etc.	0.089	0.057
Total	1.043	0.954

The temperature of the different springs varies from 53.6° to 124° F.

A course at Rennes-les-Bains is recommended to those suffering from rheumatism, irritable nervous conditions, so-called scrofulous bone and joint affections, and enlarged glands, and also certain forms of cutaneous diseases. *T. L. S.*

REPTILES, POISONOUS. The popular mind, from the earliest period of historic time, has always turned with awe and wonder toward those mysterious gliding forms which hold in their economy the power of a swift and terrible death, a power which seems in no degree commensurate with the size of the destroyer; and this being the case, it is not to be wondered at that reptiles, particularly serpents, should have been objects of veneration and worshipped as gods, as they are even to the present day.

It would be foreign to the purpose of this paper to attempt a history of the serpent cult of all ages, its object being to call attention to certain poisonous forms, and to point out such remedial methods as may possibly mitigate the human suffering which they cause, or save the lives which they imperil.

In the subject matter which follows, no extended account of all the poisonous reptiles of the known world will be given, as this would require more space than could be allowed, but a list of our own species is furnished, with brief description of their appearance, characteristics, and the manner in which they destroy life by their bite. The physiological action of the different venoms will also be mentioned. Supplementary to this will be found brief notices of some of the more important forms of the old world.

For present convenient purposes the reptilian fauna of the United States may be considered as occupying an area bounded upon the north by the line of the Northern Boundary Survey, upon the east by the Atlantic Ocean, upon the west by the Pacific Ocean, and south by an imaginary line drawn from the southern extremity of the peninsula of California, extending eastward to the point of the Floridian peninsula.

In this vast extent of country naturalists have discovered no less than twenty-seven well-marked species of poisonous serpents, in four genera, and one poisonous lizard, the latter being the only one so far found upon the habitable globe. The first genus, *Crotalus*, contains fourteen species; the second, *Caudisona*, four species; the third, *Ancistrodon*, four species; the fourth, *Elaps*, five species; the lizard belonging to the genus *Heloderma*. The names of the serpents belonging to the genus *Crotalus* (the true rattlers) are as follows:

Crotalus lepidus Kennicott, Kennicott's Rattlesnake.
Crotalus pyrrhus Cope., Red Rattlesnake.
Crotalus Mitchelli Cope., Mitchell's Rattlesnake.
Crotalus cerastes Hallowell, Horned Rattlesnake, "Side-winder."
Crotalus tigris Kennicott, Tiger Rattlesnake.
Crotalus enyo Cope., St. Lucas Rattlesnake.
Crotalus horridus Linn., Banded Rattlesnake.
Crotalus adamanteus Beauvois, Diamond Rattlesnake.
Crotalus atrox Cope., Arizona Diamond Rattlesnake.
Crotalus scutulatus Cope., Scutulated Rattlesnake.
Crotalus lucifer Baird and Girard, California Rattlesnake.
Crotalus polystictus Cope., Spotted Rattlesnake.
Crotalus confluentus Say, Confluent Rattlesnake.
Crotalus molossus Baird and Girard, Black-tail Rattlesnake.

Belonging to the genus *Caudisona* are the following:
Caudisona rava Cope., Mexican Ground Rattlesnake.
Caudisona miliaria Linn., Southern Ground Rattlesnake.
Caudisona Edwardsi Baird and Girard, Sonora Ground Rattlesnake.
Caudisona tergemina Say, Black Rattlesnake, Prairie Rattlesnake, Massasauga.

The genus *Ancistrodon* (Moccasin and Copperheads) contains the following:
Ancistrodon piscivorus Lacépède, Water Moccasin.
Ancistrodon pugnax Lacépède, Texas Moccasin.
Ancistrodon contortrix Linn., Copperhead, Moccasin, Cottonmouth, Red-eye.
Ancistrodon atrofuscus Troost, Troost's Moccasin.

The genus *Elaps* (Vipers) contains:
Elaps fulvius Linn., Harlequin Snake, Viper.
Elaps tener Linn., Texas Harlequin Snake.
Elaps euryxanthus Kennicott, Sonora Harlequin Snake.
Elaps distans Kennicott, Florida Harlequin Snake.
Elaps tristis Baird and Girard, Tawny Harlequin Snake.

The poisonous lizard is known to science as:
Heloderma suspectum Cope., Gila Monster.

It should be stated that this list is in accordance with the "Check-list of North American Reptilia and Batrachia," Bulletin No. 24 of the National Museum, and is adopted, provisionally, by the authorities of that institution.

In view of the very general ignorance regarding the appearance of the venomous reptiles of this country, it seems desirable to give a brief account of their generic differences, as well as an account of the specific peculiarities of some of the well-known forms of the genera mentioned. *Crotalus*, *Caudisona*, and *Ancistrodon* belong to the family Crotalidæ, the remaining genus, *Elaps*, being a Colubrine serpent. The family characteristics of the Crotalidæ may be broadly stated as having erectable poison-fangs in front, few or no teeth in the upper jaw, a deep pit between the eye and the nostril; the general characteristics being as follows—the upper surface of the head is covered with small plates, scale-like in appearance, with a few larger ones in front; the tail terminates in a well-developed rattle; there is a deep pit between the eyes and the nostrils; the shields of the temporal and labial region are small and convex. Figs. 3231 and 3232, representing the head of *Crotalus atrox*, show very plainly the peculiarities named.

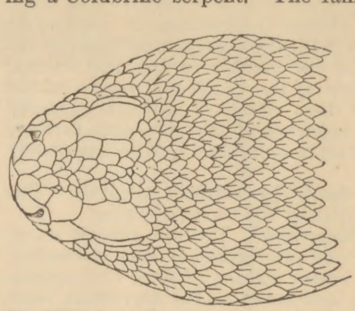
Fig. 3231.—Crotalus Atrox. View of head from above.

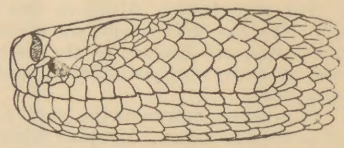
Fig. 3232.—The same, as seen in side view.

In *Caudisona* the upper surface of the head is covered with nine large plates, as is seen in the Colubrine snakes, and the tail terminates in a rattle, generally smaller than that of *Crotalus*. Figs. 3233 and 3234 represent the appearance of the head of *Caudisona tergemina*, and by comparing these figures with those of *Crotalus*, the difference in the head plates will be plainly seen. The pits anterior to the eye are also discernible.

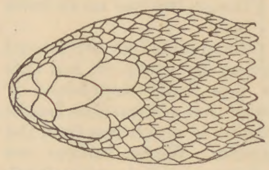
Fig. 3233.—Caudisona Tergemina. View of head from above.

In the genus *Ancistrodon*, the fangs are similar to those of *Caudisona*, and the ante-orbital pit is also present. There is no rattle on the tail, and the head is covered by either nine or eleven scales. Of the different species of this genus, one, *A. contortrix*, the Copperhead, is terrestrial, the others aquatic in their habits. Figs. 3235 and 3236 represent the head of *Ancistrodon contortrix*, the common Copperhead.

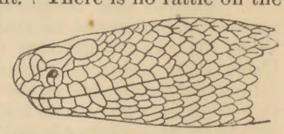
Fig. 3234.—The same, as seen in side view.

Elaps, the only venomous Colubrine serpent of North America, differs so materially from the other venomous serpents that a careful description seems necessary. The body, instead of being thick and stumpy, is slender and cylindrical, never exceeding four feet in length. The head is continuous with the body, not separated by a narrow neck as in *Crotalus*; it is subelliptical in shape, tapering forward, and is covered with plates. There is no ante-orbital pit. The mouth is not dilatable, and the upper jaw is furnished on each side with a small permanently erect fang, which is situated farther back than that of the Crotalidæ. The tail is slender and continuous with the body, and has no rattle. All the scales of the body are smooth, not keeled as in *Crotalus*. Figs. 3237 and 3238 represent the head of *Elaps fulvius*, the Harlequin Snake.

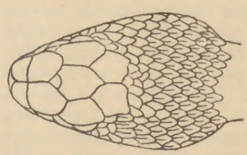
Fig. 3235.—Ancistrodon Contortrix. View of head from above.

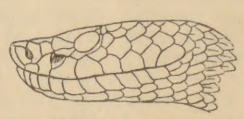
Fig. 3236.—The same, as seen in side view.

Reptiles.

The colors of the different species of this genus are generally red for the body tint, with black, red, or yellow annulations, and their similarity to certain non-venomous snakes makes them particularly dangerous, as instances are on record of individuals having suffered in consequence of handling what were supposed to be innocuous serpents, but which really belonged to the genus *Elaps*.

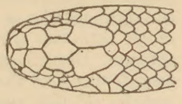

FIG. 3237.—Elaps Fulvius. View of head from above.

The genus *Heloderma* contains but one species, viz., *Heloderma suspectum*, the "Gila Monster," which may be described as a large stumpy lizard with a short tail, the whole reptile seldom exceeding eighteen inches in length. The head, sub-triangular in shape, is separated from the body by a constricted neck, and the whole of its upper surface is covered with ovoid tuberculated scales. The color is brownish-black, interspersed with yellowish spots. (See Plate XXVIII.) It is of interest because of the peculiar character of the teeth, which somewhat resemble those of poisonous serpents. Dr. Jacob Wortman, who has made a careful study of the dentition of this curious reptile, states as follows:

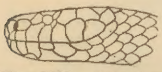

FIG. 3238.—Side view of the same.

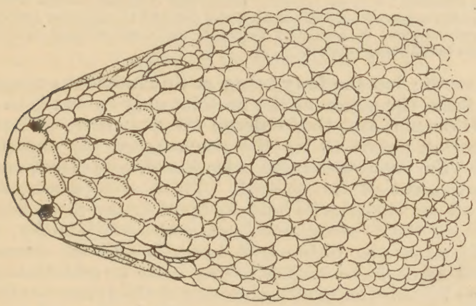

FIG. 3239.—Heloderma Suspectum, as seen from above.

"The form of the crown is that of a long, slender, sharp-pointed cone, curved inward and backward. The anterior outer surface of each tooth is marked by a well-defined groove, extending from the base to the apex. It is somewhat deeper at the base than at the summit, and is most distinct in the teeth of the lower jaw. The intervals between the bases of the teeth allow abundant room for the accommodation of poison-glands, the secretion of which is conveyed down the grooves and thus injected into the wound which the teeth inflict upon a prey."

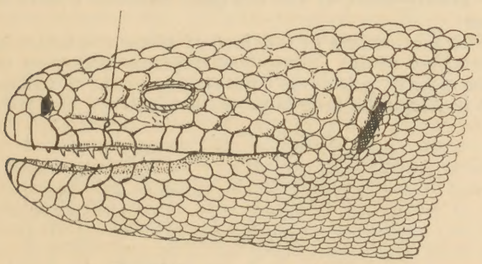

FIG. 3240.—The same; side view.

Whether true poison-glands actually do exist, has not yet been accurately determined. Figs. 3239 and 3240 will convey an excellent idea of the appearance of the head of the *Heloderma*, seen from above and in profile; the black line running vertically through the snout, having a hook at its lower end, is intended to show the lip drawn up, as under ordinary circumstances the teeth are concealed by the lips.

Having thus briefly considered the characteristics of the venomous reptiles, it may be proper to give a description of the mechanism which controls and operates the poison-fang apparatus of all our venomous serpents with the exception of *Elaps*, the account being substantially the same as was published by Dr. Elliot Coues and the writer as a result of their herpetological studies, a few years since, more modern researches having in no wise induced an alteration of the opinions then expressed.

In the production of the bite the active instruments are a pair of deciduous fangs, one on each side of the upper jaw, rooted in the maxillary bones, which bear few, if any, other teeth; but it should be mentioned as a matter of interest that, while in *Crotalus confluentus* the fangs are generally shed or pushed out of place at variable periods of time (probably in twelve months), in *Crotalus atrox*, a species common in the Sonoran region, this shedding or loss frequently fails to take place, and it is common to find, generally in the right side of the jaw of this species, two or more fangs in position. In one specimen, in possession of the National Museum, three are to be seen in position, and behind them are others well advanced in growth. The fangs vary in size, being sometimes three-fourths of an inch in length. They are somewhat conical and scythe-shaped, with an extremely fine point; the convexity looks forward, the point downward and backward. The fang is hollow for the transmission of the venom, but the construction of the tube is not as if a hole had been bored through a solid tooth. It is in effect a flat tooth, with the edges rolled over together till they meet, converting an exterior surface, first into a groove, finally into a tube. This is shown, on microscopic examination of a section of the tooth, by the arrangement of the dentine. Unlike an ordinary tooth, the fang is movable, and was formerly supposed to be hinged in its socket, since it is susceptible of erection and depression. But the tooth is firmly socketed, and the source of this movement is the maxillary bone itself, which rocks to and fro by a singular contrivance. The maxillary is a small, stout, triangular bone, movably articulated above with a smaller one, the lachrymal, which is itself hinged upon the frontal. Behind, the maxillary articulates with the palatal and pterygoid, both of which are of rod-like shape, and are acted upon by the spheno-pterygoid muscle, the contraction of which pushes them forward. This forward impulse of the palatal and pterygoid is communicated to the maxillary, against which they abut, causing the latter to rotate upon the lachrymal. In this rocking forward of the maxillary, the socket of the fang, and with it the tooth itself, rotates in such manner that the apex of the tooth describes the arc of a circle, and finally points downward instead of backward. This protrusion of the fang is not an automatic motion, consequent upon mere opening of the mouth, as formerly supposed, but a volitional act, as the reverse motion, namely, the folding back of the tooth, also is; so that, in simply feeding, the fangs are not erected. The folding back is accomplished by the ecto-pterygoid and spheno-palatine muscles, which, arising from the skull behind as a fixed point of action, in contracting draw upon the jaw-bones in such a way that the maxillary, and with it of course the fang, are retracted, when the tooth is folded back with an action comparable to the shutting of the blade of a pocket-knife. All the motions of the fangs are controlled by these two sets of antagonistic muscles, one of which prepares the fangs for action, while the other stows them away when not wanted.

The fangs, when not in use, are further protected by a contrivance for sheathing them, so that they rest like a sword in its scabbard. This is a fold of mucous membrane, the *vagina dentis*, which envelops the tooth like a hood, enwrapping its base, and slipping down over its length, partly as a consequence of its elastic texture, partly on account of its connections. Erection of the fang causes the sheath to slip off, like the finger of a glove, and gather in folds around the base of the tooth. This arrangement can readily be examined without dissection.

The poison-fluid is secreted in a gland which lies against the side of the skull, below and behind the eye, of a flattened oval shape, obtuse behind, tapering in front to a duct that runs to the base of the tooth. Without

going into the minute anatomy of the gland, it may be described as a sac, or reservoir, in the walls of which the numerous secretory follicles are imbedded; it is invested with two layers of dense, white, fibrous tissue, the outer of which gives off three strong ligaments that hold it in place. In a large snake, the entire gland may be nearly an inch long and one-fourth as wide, weighing, empty, ten or twelve grains, and having a capacity of ten or fifteen drops of fluid. There is no special reservoir for the venom, other than the central cavity of the gland. A certain dilatation of one portion of the duct, formerly supposed to be such a store-house, is due to thickening of its walls, without corresponding increase of capacity, resulting from muscular fibres which serve as a sphincter to compress the canal and prevent wasteful flow of the contents. There is further provision to this same end. When the tooth is folded back, the duct attached to its root is submitted to some strain, which pushes it against a shoulder of the maxillary bone, and tends to shut off the communication.

The injection of the venom, though to all appearance instantaneous, is a complicated process of several rapidly consecutive steps. Forcible voluntary closure of the jaws may always be, if desired, accompanied by a gush of the venom, owing to the arrangement of the muscles which effect such movement of the jaw. These are the *temporales*, one of the three of which is situated in such relation to the poison-sac that its swelling in contraction presses upon the receptacle and squeezes out the fluid. The force of ejection is seen when the serpent, striking wildly, misses its aim; under such circumstances, the stream has been seen to spirt five or six feet. A blow given in anger is always accompanied by the spirt of venom, even when the fang fails to engage, from whatever cause. But since this result does not follow upon mere closure of the mouth, it is probable that the two posterior temporals ordinarily effect this end, the more

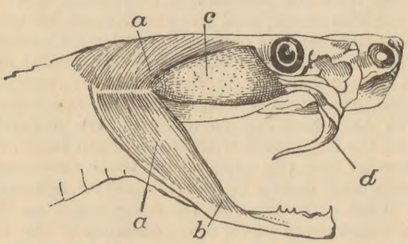

FIG. 3241.—Head of Crotalus. *a*, *a*, Anterior temporal muscle; *b*, point of insertion in the lower jaw; *c*, venom-gland; *d*, fang, partly erected.

powerful action of the anterior temporal (the one which presses upon the poison-sac) being reserved for its special purpose. There is one curious piece of mechanism to be noted here. Since the serpent snaps its jaws together in delivering a blow, the points of the fangs would penetrate the under jaw itself in case they failed to engage with the object aimed at, were there no contrivance for preventing such disaster to the snake. But there is a certain movement among the loose bones of the skull, perhaps not well made out, the result of which is to spread the points of the fangs apart in closure of the mouth, so that they clear the sides of the under jaw, instead of impinging upon it.

The complicated mechanism of the act of striking may be thus described: The snake prepares for action by throwing itself into a number of superimposed coils, upon the mass of which the neck and a few inches more lie loosely curved, the head elevated, the tail projecting and rapidly vibrating. At the approach of the intended victim, the serpent, by sudden contraction of the muscles upon the convexity of the curves, straightens out the anterior portion of the body, and thus darts forward the head. At this instant the jaws are widely separated, and the back of the head fixed firmly upon the neck. With the opening of the mouth the spheno-palatines contract, and the fangs spring into position, throwing off the sheath as they leap forward. With delivery of the blow and penetration of the fangs, the lower jaw closes forcibly, the muscle that executes this movement causing simultaneously a gush of venom through the tubular tooth into the wound. There are also some secondary actions, though all occur at the same moment. The mouth fixed at the wound drags upon it with the whole weight of the snake's body. This dragging motion is accompanied by contraction of the ecto-pterygoid and the spheno-palatine muscles, which ordinarily fold back

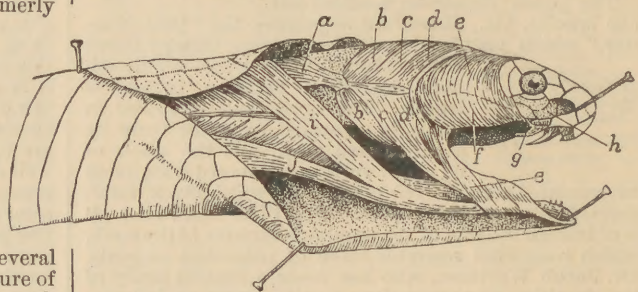

FIG. 3242.—Naja Tripudians. *a*, Is the trachelo-mastoid muscle; *b*, *b*, the digastric; *c*, *c*, the posterior temporal; *d*, *d*, the anterior temporal; *e*, *e*, the masseter; *f*, the poison-gland covered by masseter and fascia; *g*, poison-duct; *h*, maxillary bone; *i*, neuro-mandibular muscle; *j*, costo-mandibular muscle.

the tooth; but the fang being at this moment engaged in the flesh, the action of the muscles only causes it to bury itself deeper, and thus enlarge the puncture. The train of action seems to be, the reaching of the object, the blow, the penetration, the injection of the poison, and the enlargement of the wound. These actions completed, the serpent loosens its hold by opening the jaws, and disengages itself, sometimes not without difficulty, especially when the bitten part is small and the numerous small teeth have caught. The head is withdrawn, the fangs folded, the mouth closed, and the former coiled attitude of passive defence is assumed.

Fig. 3241, after Mitchell, represents the head of *Crotalus*, and shows the relation of the temporal muscles to the venom-gland, and the mode in which the pressure is exerted upon the poison-gland at the proper moment.

Fig. 3242, copied from Sir Joseph Fayrer's admirable work on the Thanatophidia of India, represents the head of *Naja tripudians*, the Cobra, the different muscles involved in the movements of the jaws and fangs being carefully delineated. By comparing this cut with Fig. 3241, it will be noticed that the fangs are fixed more anteriorly in the upper jaw than those of *Crotalus*, and the arrangement of the temporal muscles differs somewhat.

The mechanism of the jaw of *Elaps* resembles somewhat that of the Cobra, both reptiles belonging to the same class of poisonous colubrine serpents, the Elapidæ; but in *Elaps* the fang is permanently erect, the jaws being less dilatable than in most venomous species. This fact explains why it is that the death-dealing power of *Elaps* is more restricted than in other species.

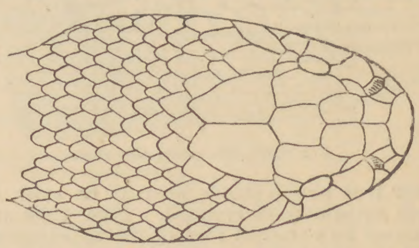

FIG. 3243.—Head of Naja Tripudians, as seen from above.

Figs. 3243 and 3244 represent the head of *Naja tripudians* seen from above and in profile, and shows the characteristic appearance of the heads of the venomous colubrine serpents.

It is a curious fact, that notwithstanding the knowledge possessed for ages regarding the poisonous effect of serpent venom, until within the last three centuries no attempt was made to study its peculiar physiological

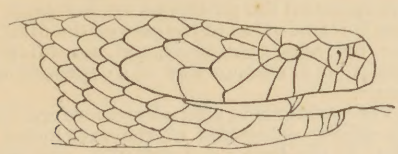

FIG. 3244.—The same, as seen in side view.

effects, the first writer on the subject being Francisco Redi, an Italian, who in 1664 published, at Florence, a paper upon the venom of the viper, entitled "Osservazione intorno alle Vipera," and this was followed, in 1767, by a work which may be considered classic, written by Felix Fontana, entitled "Richerche filosofiche sopra il veneno della Vipera," published in Lucca. In 1845, the naturalist, Prince Lucien Bonaparte, published a paper on the results of his analyses of viper venom, which was really the first scientific chemical study made. A number of other papers appeared from time to time subsequent to this, but it was not until 1860 that the most important work on serpent venom appeared. This was the "Study of the Venom of Rattlesnakes," by Dr. S. Weir Mitchell, of Philadelphia, and appeared as a volume of one hundred and seventeen quarto pages in the Smithsonian Contributions to Knowledge. In 1868, this distinguished physician supplemented his first paper by one in the *New York Medical Journal*, and in 1886, in collaboration with Dr. Edward T. Reichert, the great work entitled, "Researches upon the Venoms of Poisonous Serpents," appeared as No. 647 of the Smithsonian Contributions to Knowledge. It should not be forgotten that while our own countrymen were seeking to diffuse knowledge among mankind, the subject of serpent venom was being investigated by scientists abroad. In 1872 Sir Joseph Fayrer published a work on the venomous serpents of India; Dr. Lauder Brunton and himself published in the same year an admirable physiological study of venoms. In 1883, appeared a comparative study of the venoms of the colubrine and viperine snakes of India, by Dr. A. J. Wall; nor should the work on antidotes, by Vincent Richards, be forgotten.

The physical appearances of all serpent venom are nearly alike, varying in color from pale amber to deep yellow when fresh, although it has been stated that occasionally the *Cobra* venom is colorless; and this finds its analogy in the venom of our own *Elaps*, which has been seen on one occasion to lack color. In the desiccated condition venom appears as yellow particles, semi-transparent, and remains unchanged for long periods of time. It is equally virulent whether dry or preserved in alcohol or glycerine, Dr. Mitchell having in his possession a glycerine solution which was poisonous after twenty years' preservation. For a full description of the microscopic appearance and the changes which venom undergoes the reader is referred to the admirable study by Mitchell and Reichert already mentioned. So far as the chemistry of venom is concerned, the presence of alkaloids and ptomaïnes has long been suspected, but up to the present time they have been sought for in vain; but Mitchell and Reichert have succeeded in isolating certain principles belonging to two classes, the former termed globulins, the other peptones. To the first belong complex substances which they call *water-venom-globuline*, *copper-venom-globuline*, and *dialysis-venom-globuline*, these names indicating the chemical processes by which they have been separated. The venom peptone is found in a solution of the poison after boiling, which coagulates the albuminous principles, or it may be prepared by dialysis. In the cobra venom Drs. Mitchell and Reichert have been able to isolate two proteids which are similar in character to those found in the venoms of *Crotalus* and *Ancistrodon*, which are a globulin and peptone-like principle. From a careful series of analyses it has been found that the venom of *Crotalus adamanteus* contains 24.6 per cent. of globulins, that of *Ancistrodon* 7.8 per cent., and that of the cobra 1.75 per cent. Serpent venom has been subjected to the action of various agents with a view to determine the effects in reducing its toxic power. Dry and moist heat have little if any effect, but prolonged boiling seems to reduce the poisonous quality, owing to the fact that the peptone is converted into a coagulable albuminoid which is not destructive to life. The addition of a sufficient quantity of caustic potassa to a solution of venom, absolutely destroys the toxic power, and caustic soda appears to have the same effect. A number of other substances have been employed, but space will not admit of a further consideration of the results attained; but it may be stated as a matter of interest that a solution of the permanganate of potassa is said to be an absolute chemical antidote to serpent venom.

Much might be said of the effects of venom, but a brief notice seems all that is necessary, as the subject has been most elaborately discussed by the authors already quoted. *Crotalus* poison, if swallowed, is harmless, as it is not absorbed by the healthy mucous membrane, or because it undergoes some change in the progress of digestion which makes it harmless; but Fayrer has found that the ingestion of cobra poison by mammals does produce death. When venom is applied to serous surfaces absorption takes place most rapidly, and hæmorrhagic patches occur with surprising celerity. According to Mitchell, after the hypodermic injection of venom, the following pathological appearances may be noticed: "There appears a swelling at the point of injection, with intense violet-black discoloration of the skin which gradually extends over an area of several square inches. On making an incision into the tissues in the immediate neighborhood of the injection, they are found to be soaked with extravasated blood. This is often all that is visible if death has occurred soon, but if it has been postponed for a short time, then, in tissues distant from the place of injection, extravasations to a smaller extent are always found. Most pronounced and most frequent are the ecchymoses below serous membranes (subpleural, subperitoneal, and subpericardial); in fact the whole organism is deeply affected, the tissues being congested and presenting a much darker appearance than normal. The blood does not seem to coagulate readily within cavities or interstices of the body unless death follows almost instantaneously. In cases which live longer the blood remains constantly in a liquid state, or coagulates imperfectly, and then only after being exposed to the air, resembling in this particular the state of that fluid observed in conditions of asphyxia."

As the valuable work of Mitchell and Reichert is not generally available to the public or practitioners of medicine, it may be proper to give in their own words a summary of the conclusions arrived at, as a result of their most valuable and careful studies:

"1. Venoms bear in some respects a strong resemblance to the saliva of other vertebrates.

"2. The active principles of venom are contained in its liquid parts only. The solid constituents, such as we observed suspended in the poison, consist of epithelium cells, some minute rod-like animal organisms and micrococci, etc., which, when separated from the liquid, fresh venom by means of filtration and well washed by water, are harmless. Micrococci are constantly present in fresh venom, but have nothing to do with its virulence.

"3. Venoms may be dried and preserved indefinitely in this condition, with but very slight impairment of their toxicity. In solution in glycerine they will also probably keep for any length of time.

"4. There probably exist in all venoms representatives of two classes of proteids, *globulins* and *peptones*, which constitute their toxic elements; the former may be represented by one or more distinct principles.

"5. When venom is taken into the stomach in the intervals of digestion, enough of the poison may be absorbed to produce death, especially in the case of those venoms which contain a larger proportion of the more

dialysable peptone; but during active digestion the venom undergoes alteration, and is rendered harmless.

"6. Potassic permanganate, ferric chloride in the form of the liquor or tincture, and tincture of iodine seem to be the most active and promising of the generally available local antidotes.

"7. Venom exerts a powerful local effect upon the living tissues, and induces more rapid necrotic changes than any known organic substance. It causes œdema, swelling, attended with darkening of the parts by infiltration of incoagulable blood, breaking down of the tissues, putrefaction, and sloughing.

"8. It renders the blood incoagulable.

"9. When brought in contact with a vascular tissue of a warm-blooded animal, it produces such a change in the capillary blood-vessels that their walls are unable to resist the normal blood-pressure, thus allowing the blood-corpuscles to escape into the tissues. These lesions are, however, not analogous to those of inflammation, since in the latter process it is principally the white blood-corpuscles which emigrate from the vessels, and the blood is highly coagulable, while here the blood exudes *en masse*, and coagulates with difficulty, if at all. Free access of air (probably of oxygen) appears to lessen the virulent effects. The mesentery exposed to air, and on which the venom is merely brushed, endures the venom longer and in much larger quantities than when the poison is injected into the unopened and uninjured peritoneal cavity, or when directly thrown into the blood. There may be here, also, a question of temperature and other conditions.

"The following facts, as elicited in these investigations, seem to be sufficient to explain the mechanism of the hæmorrhages: The blood-pressure has been shown to play a most important part; a watery salt solution substituted for the blood does not extravasate, hence blood seems to be necessary; there always occur molecular changes in the blood-vessel walls from the effect of venom. That blood-pressure is an important factor has been established by the observation that the hæmorrhages, as a rule, occur first in the capillaries which are immediately next to, or nearest, the large blood-vessels. The hæmorrhages take place soonest where the force of the blood-current is first felt and cannot be sufficiently resisted, and in no case do hæmorrhages seem to originate from vessels with strong walls, like the arterioles or veins. Cutting off the circulation of a part, as, for instance, by ligation of the vessel of the mesentery, destroys the blood-pressure, and, as a consequence, the hæmorrhages are so slight as scarcely to be seen by the naked eye, though venom was freely applied. Finally, the colloid, softened, diffluent condition of the red corpuscles must inevitably facilitate extravasation. It is impossible to have seen numerous cases of venom-poisoning without noting a variety of symptoms often abrupt or unexpected. These often are due, as Dr. Mitchell long since pointed out, to accidental hæmorrhages into the brain, kidney, and heart tissues. They explain much which might otherwise seem inscrutable, and serve sometimes to give a marked individuality of symptoms to cases which survive long.

"10. Among the most remarkable effects of venom is that upon the red blood-corpuscles. These bodies undergo substantial modifications, *i.e.*, they lose their biconcave shape, become spherical and softened, and fuse together into irregular masses, acting like soft, elastic, colloid material. This jelly-like condition of the corpuscles is, no doubt, doubly important: in connection with the extravasation of the blood, and in its probable interference with the normal respiratory functions of the blood-cells.

"11. The direct action of venom upon the nervous system, save as concerns the paralysis of the respiratory centres, is of but little importance.

"12. The alterations in the pulse-rate are dependent chiefly upon two antagonistic factors which are active at the same time, the one tending to increase the rate, and the other to diminish it. The former is found in the increased activity of the accelerator centres, and the other in a direct action on the heart. When we have the action of the accelerator centres removed by isolation of the heart from any centric influence, we almost invariably find a diminution of the heart-beats. Occasionally after this operation the pulsations are increased, but this alteration is attended, as in the case of the diminution of the pulse, by feeble heart-beats, and, accordingly, is but a manifestation in another way of a depressed condition of the heart.

"13. The variations in arterial pressure are due chiefly to three causes—depression of the vaso-motor centres, depression of the heart, and irritation, and consequent constriction or blocking up, of the capillaries. It seems not improbable that all of these are consentaneously active, and it therefore follows that such alterations are dependent upon the relative degree of power exerted by any one of these factors. Our results indicate that the profound primary fall of arterial pressure is chiefly due to depression of the vaso-motor centres, and is in part cardiac, that the subsequent recovery is capillary, while the final fall is cardiac. The initial fall does not continue, because the constriction of the capillaries is, for a time at least, capable of compensating the depressed action of the central organ of circulation.

"14. The respirations are primarily increased and secondarily diminished. Here again we have two antagonistic factors at work together, one tending to increase and the other to diminish the rate. The former is an irritation of the peripheries of the vagi nerves, and the latter a depression of the respiratory centres; whether we have an increase followed by a decrease, or a decrease from the first, will depend upon the relative intensity of the action of the venom on these two parts. When the action of the venom is sufficient to profoundly depress the centres the excitation of the peripheries may prove futile.

"15. Death in venom-poisoning may occur through paralysis of the respiratory centres, paralysis of the heart, hæmorrhages in the medulla, or possibly through the inability of the profoundly altered red corpuscles to perform their functions. There can be no question, however, that the respiratory centres are the parts of the system most vulnerable to venom, and that death is commonly due to their paralysis.

"A general survey of the chief physiological actions of venoms leads us to believe that the most important effects are upon the respiratory and circulatory apparatuses, and that in the production of these results antagonistic factors are at work, so that we sometimes have observations which seem directly contradictory. When it is remembered that there are two classes of poisons in venoms, that each class possesses certain distinguishing physical, chemical, and physiological differences, although closely related, it is easy to conceive of the cause of the existence of antagonistic actions and the necessarily varying results.

"A comparative study of the actions of the *globulins* and *peptones* indicates that the *globulins* produce swelling and blackening of the parts by infiltration of incoagulable blood; they are the more potent in producing ecchymoses, in destroying the coagulability of the blood, in modifying the red corpuscles, and in the production of molecular changes in the capillary walls; their action on the accelerator centres of the heart is more notable than that of the *peptones*, hence they are more active in causing the increased pulse-rate; they exert, too, a more marked action on the vaso-motor centres in producing the primary fall of pressure, and are the greater depressants of the heart; they also act more powerfully upon the respiratory centres to paralyze them. The *peptones* are more active in the production of œdema, in the breaking down of the tissues, in the production of putrefaction and sloughing; they have little power to produce ecchymoses, to prevent coagulation, or modify the capillary walls or the blood-corpuscles; they have less tendency to accelerate the pulse; they tend to increase the blood-pressure by irritating the capillaries, and are the principal factors in exciting the peripheries of the vagi

nerves in the production of the increased respiration-rate.

"A knowledge of these peculiarities in the actions of *globulins* and *peptones*, coupled with the fact that the two classes exist in different proportions in the various species of venoms is of great importance in explaining the diverse pathological appearances in cases of poisoning in different kinds of snake-bite, and suggests immediately the cause of the frightful local changes which are seen after the bite of the Crotalidæ, but scarcely at all in cobra-poisoning. It must not, however, be supposed that the peptones or globulins, for instance, are absolutely identical physiologically in every venom, as they are probably modified physiologically as well as chemically, although we do not doubt that on the whole the type of action is carried throughout all species. Cobra venom does not produce the marked lesions of crotalus-poisoning because it is so lacking in globulins; it is weak in the production of the local swelling and blackening of the parts, of the ecchymoses, of the altered corpuscles, and of the non-coagulability of the blood; but the effects of cobra venom are closely in accord with the actions peculiar to peptones. The peptone of cobra seems to have a more decided power in producing convulsions than that of the rattlesnake.

"The fact that the active principles of venom are proteids, and closely related, chemically, to elements normally existing in the blood, renders almost hopeless the search for a chemical antidote which can prove available after the poison has reached the circulation, since it is obvious that we cannot expect to discover any substance which, when placed in the blood, will destroy the principles of venom without inducing a similar destruction of vital components in the circulating fluid. The outlook, then, for an antidote for venom which may be available after the absorption of the poison, lies clearly in the direction of a physiological antagonist, or, in other words, of a substance which will oppose the actions of venom upon the most vulnerable parts of the system. The activities of venoms are, however, manifested in such diverse ways, and so profoundly and rapidly, that it does not seem probable that we shall ever discover an agent which will be capable at the same time of acting efficiently in counteracting all the terrible energies of these poisons."

With regard to the poisonous effects produced by the venom of the *Ancistrodons* (Moccasins and Copperheads), the reader is referred to an article by the writer which appeared in the *American Journal of the Medical Sciences*, Philadelphia, April, 1884, in which special attention is called to the recurrence of symptoms of poisoning after snake-bite; this recurrence seems to be confined to cases in which individuals were bitten by the serpents of the genus named. In the *Medical News*, Philadelphia, 1887, i., p. 623, the writer, after carefully watching the two cases mentioned in the former paper during a period of nearly three years, published a short paper upon the "Recurrence of Symptoms of Poisoning after Snake-bite," in which the results of the examination of the patients and the recurrent symptoms are fully set forth.

With regard to the poisonous lizard, *Heloderma suspectum* (Gila Monster), there is a mass of conflicting evidence as to its toxic power. The Mexicans have long looked upon it as dangerous, but other perfectly harmless lizards also share in this evil reputation. Surgeon B. J. D. Irwin, U. S. A., experimented many years since, while on duty in New Mexico, with the Gila Monster, and concluded that it was harmless, and a number of persons have been bitten, within the writer's knowledge, without evil results. In fact, in New Mexico and Arizona the reptile is kept as a domestic pet, and handled with great carelessness. Opposed to the view of its non-dangerous nature are the facts that persons have undoubtedly perished from its bite, the writer having in his possession the affidavits of two respectable individuals who witnessed a death, and the experiments of Mitchell and Reichert, which conclusively show that the saliva-like fluid from the mouth of the *Heloderma*, when injected beneath the skin of an animal, produces fatal results with great rapidity.

These investigators obtained the fluid by provoking the animal to bite on a saucer edge, and after it had held on for a few moments a thin fluid like saliva was observed to issue from the lower jaw. This fluid was distinctly alkaline, differing in this respect from the venom of all serpents, which is acid. The first experiment made by these gentlemen was as follows: "About four minims were diluted with one-half cubic centimetre of water, and thrown into the breast-muscles of a large, strong pigeon at 4.23 P.M. In three minutes the pigeon was rocking on its feet and walking unsteadily. At the same time the respiration became rapid and short, and at the fifth minute feeble. At the sixth minute the bird fell in convulsions, with dilated pupils, and was dead before the end of the seventh minute. The first contrast to the effects of venom was shown when the wound made by the hypodermic needle was examined. There was not the least trace of local action, such as is so characteristic of the bites of serpents, and especially the Crotalidæ. The muscles and nerves responded perfectly to weak induced currents, and to mechanical stimuli. The heart was arrested in the fullest diastole, and was full of firm, black clots. The intestines looked congested. The spine was not examined."

Subsequent experiments with rabbits and frogs produced like results, the conclusions of the authors being, "That the poison of *Heloderma* causes no local injury. That it arrests the heart in diastole, and that the organ afterward contracts slowly—possibly in rapid rigor mortis.

"That the cardiac muscle loses its irritability to stimuli at the time it ceases to beat.

"That the other muscles and the nerves respond readily to irritants.

"That the spinal cord has its power annihilated abruptly, and refuses to respond to the most powerful electrical currents."

It should not be forgotten, however, that Dr. Sternberg and Professor Gautier have proved that human saliva may produce death in rabbits and pigeons, the latter observer considering the venomous properties due to normal ptomaines or animal alkaloids.[1]

It is by no means uncertain that in the near future it may be shown that the saliva of other reptiles possesses poisonous qualities, especially in such genera as *Siren*, *Pseudobranchus*, *Necturus*, *Amphiuma*, *Murænopsis*, and *Menopoma*, which in the Southern States are popularly supposed to be able to destroy life by their bite.

The *symptoms* produced in man by the bites of poisonous serpents possess a certain degree of similarity, their gravity depending largely upon the size of the reptile and the amount of venom injected into the wound. In case the serpent had repeatedly used its fangs and exhausted the supply of venom, dangerous symptoms would be less pronounced. Briefly, they may be stated as follows: After the puncture, at first the pain is slight in the part; this gradually increases along the line of the lymphatics, with nausea; bleeding takes place, with rapid tumefaction and discoloration in the vicinity of the wound. The pulse is feeble and fluttering, and in some cases, when an overwhelming dose of the venom has been received, the action of the heart is almost paralyzed. If remedial means are not employed there is exaggeration of all the symptoms mentioned, with incontinence of urine and involuntary passage of fæces, delirium, coma, and death, which may occur within a few hours.

These symptoms may be immediate or delayed, as in the case of the photographer bitten by a copperhead, and reported by the writer, as in this individual several days elapsed before any real suffering commenced, the entire duration of the poisonous symptoms lasting from May 30th until late in August.

Regarding the *treatment* of poisoning by serpent venom, many plans have been suggested, and hundreds of remedies employed with varying success; but to an intelligent observer of such an accident the indication would doubtless be to prevent the entrance of the poison

into the general circulation by means of a ligature or bandage, which should not be narrow, but quite broad, and applied above the bite or between it and the heart, it being, of course, understood that these remarks, so far as ligatures are concerned, apply to wounds of limbs. The bite or bites should then be laid open by crucial incision, care being taken not to injure blood-vessels, and suction should be made, either by the mouth (in case no abrasions of the mucous surface exist), or by cupping; this latter procedure may be made by means of surgical cups if available, by a small tumbler or wineglass from which the air has been exhausted by burning a small quantity of alcohol or spirits therein, or by means of an ordinary wide-mouthed bottle or can, in which boiling-hot water should be poured and quickly emptied. Alcoholic stimulants or digitalis should be given by the mouth, or hypodermatically if nausea exists, to keep up the flagging heart, and the band should be loosened for a few moments at a time in order that only a small quantity of the venom shall enter the circulation. This process should be repeated, and the pulse will indicate when the proper amount of stimulation has been reached. It is not necessary to produce drunkenness, as it is believed that in some cases, especially of children, death has resulted not from the snake venom, but from lethal doses of alcohol. The mountaineers of the West attach much virtue to the flashing of a quantity of gunpowder over the bite, this, with cataplasms of tobacco and unlimited whiskey, constituting almost their entire pharmacopœia.

Within a few years, however, the attention of those interested in the subject of serpent-bite has been called to the elaborate experiments of Dr. J. B. de Lacerda, Director of the Physiological Laboratory of the National Museum of Rio Janeiro—a study followed with most conscientious care, and one which seems to show that there exists a most potent chemical antidote to serpent venom. His researches commenced in 1872, and in 1881 he announced to the French Academy of Sciences that he had made a valuable discovery. Alluding to the inefficiency of the various so-called antidotes, he stated that he found that a solution of potassium permanganate was an absolute antidote. The venom used was from the *Bothrox*, a very well known and venomous serpent of Brazil, and it was obtained by forcing the reptile to bite upon cotton-wool. The quantity thus procured was dissolved in eight or ten grammes of distilled water, and a certain amount of the solution was injected into the leg of a dog. In a few minutes after, the same quantity of a filtered one per cent. solution of potassium permanganate was injected into the wound. Next day the animal was perfectly well, with the exception of a slight local irritation. The poison injected in other animals, without the subsequent use of the permanganate, produced grave and dangerous symptoms. The venom was also injected into a vein, and the permanganate proved equally efficacious in preventing poisonous symptoms; and in some cases, before using the antidote, the symptoms of poisoning were allowed to continue for quite a lengthy period; and out of thirty experiments all were successful with but two exceptions. It is proper to add that many of Lacerda's experiments were performed in the presence of the Emperor of Brazil, and other scientific individuals. Lacerda's experiments with the permanganate of potassa have been repeated by a number of observers with varying results, but in view of the very positive statements made by him it would appear that the permanganate should be given a trial. It should be used in the form of a one per cent. solution in water, and injected into the bites made by the teeth of the serpent.[2]

The writer, while sojourning among the Moqui Indians of Arizona, at the time of their celebrated "snake-dance," was shown the so-called antidote which they employ in case a dancer is bitten; it is a pale, dirty-green fluid, without odor, and slightly bitter taste, but its composition could not be ascertained, only two individuals in the tribe knowing how to prepare it. This preparation is used, mixed with saliva and the charcoal of piñon nuts, to smear the bodies of those Indians who are to participate in the dance, and after it is finished copious draughts of it are swallowed, which produce prompt emesis. In case one is bitten, which happens occasionally, the wound is immediately sucked, some of the antidote rubbed into the wound, and a large quantity swallowed. During the last ten years, in which period five dances have occurred, but one individual has perished from snake-bite; and this is the more surprising when the fact is made known that the salient feature of the dance consists in the dancer holding one or two rattlesnakes in the mouth. The writer saw two individuals bitten, both by harmless snakes. Unfortunately for science, no opportunity was afforded to test the permanganate solution, which had been prepared and was on hand for use should occasion offer.

After the subsidence of acute symptoms of snake-bite, the others would have to be treated according to the general indications.

Considering the number and wide distribution of venomous serpents in the United States, and in view of the fact that no absolutely reliable plan of treatment is known, it is surprising that so few individuals lose their lives from snake-bite. That the rattler is still numerous in certain portions of our country, the following statement will show: In 1876, Lieutenant Morrison, U. S. A., encountered in New Mexico a colony of *Crotalus confluentus*, of which not less than from three to five hundred were seen during the occupation of a hill as a topographical station, and of which seventy-nine were killed in less than one hour; and Professor J. A. Allen reports that during the Yellowstone Expedition of 1872, not less than two thousand were killed.

With reference to the subject of antidotes, mention may be made of a remarkable work, published by Boericke & Tafel in 1872, in which the author endeavors to prove that the galls of serpents are antidotal to their bite. In preparing the gall for use, one drop is added to ten drops of pure alcohol, and the mixture is allowed to stand for a few days, at the expiration of which period the supernatant liquid is poured off and carefully preserved in a well-corked vial. In ordinary cases of bite, five or ten drops of this tincture are added to half a tumbler of water, and a tablespoonful of the mixture is administered every five, ten, fifteen, or twenty minutes, according to the violence of the symptoms. In addition to the internal use of the gall, a cruciform incision is made over the wound, and a few drops of the preparation are dropped in. Unfortunately the value of this so-called antidote depends entirely upon the statement of its discoverer, and it is believed little credence can be attached to his published results, as Sir Joseph Fayrer, following instructions received from the author, failed utterly to neutralize the poisonous effects of the venom of *Cobra* and *Bungarus*, using the gall as directed.

The popular mind has ascribed to certain serpents properties, venomous and otherwise, which they really do not possess, and it is thought a correction of these errors may perhaps serve a useful purpose.

In some parts of the United States is found a snake belonging to the genus *Heterodon*, which inspires as much fear as the rattlesnake; in fact, the species known as *Heterodon niger* is called in Virginia the "black rattlesnake," although the want of a rattle should prove the name a misnomer. This reptile has a broad, flat head, with a somewhat constricted neck, a stout body, and a short stumpy tail, and when captured it hisses fiercely, expands the cervical ribs, and presents a very pugnacious appearance. The coloration of one species is somewhat like *Crotalus confluentus*, and, if the mouth is examined, in the upper jaw will be found fang-like teeth, which have given origin to the generic name, which means "different or dissimilar teeth." These teeth are not grooved, and are not connected with anything resembling a poison-sac. Notwithstanding its dangerous appearance it is absolutely harmless, and can scarcely be provoked to bite. Not long since, the writer had forwarded to him, by an intelligent gentleman living in the South, one of these snakes, which was declared to be one of the most poisonous known to the region; it proved to be *Hetero-*

Reptiles.

don platyrhinus. The common names for this serpent are "puff-adder," "hog-nosed snake," "sand-viper," etc.

Next to the almost universal belief regarding *Heterodon*, is a similar opinion about the so-called water moccasin, *Tropidonotus sipedon*, and one of the old writers, in a history of Virginia, describes this serpent so that no doubt as to its identity can exist, and then gravely states that an Indian was severely bitten by one, but by the application of proper remedies finally recovered. This serpent, as is well known to naturalists, resembles the poisonous species *Ancistrodon piscivorus*, and as both are found in and about watery places, it is not surprising that their properties should have been confounded. In addition, *Tropidonotus* is a very pugnacious individual, and will bite fiercely if opportunity offers, especially if it has not been handled—in fact, even then, if roughly seized. Some time since, the writer had occasion to remove a small sebaceous tumor from below the angle of the jaw of a fine female *Tropidonotus* belonging to the National Museum, and after the operation, as it had lost a considerable amount of blood, and seemed very weak, it was placed in the pond of water in the rotunda of the Museum. Desiring to exhibit it to a friend, it was removed from the water, when it struck fiercely at the hand, throwing its upper jaw back as the venomous serpents are in the habit of doing, and at the third stroke succeeded in fixing its teeth near the base of the thumb. The pain was trifling, and had it not been for the somewhat free bleeding, an injury would hardly have been suspected; no evil consequences resulted, nor have any ever occurred, as the writer has been bitten several times by this species.

The difference in the appearance of the head between the true moccasins and the so-called water moccasin is very marked. In the former the plane surface of the head may be said to roughly resemble a triangle, the snout representing the apex, the angle of the jaws the base, the neck being narrow behind. In this species the pit between the eye and nostril is well marked. In the harmless species the head is hardly separated from the body by a constricted neck; it is rounded, and the expanse of the angles of the jaw not so well marked. It has, however, when coiled up, a very vicious appearance, and resembles greatly a venomous snake.

One of the most curious myths in regard to serpents is that of the "hoop-snake" or horn-snake, which is thus described by a recent writer: "The horned snake is the last of the poisonous serpents, and is a great curiosity. Instead of in the head, it carries its weapon in its tail, which has a horny appearance, is shaped like a cock's spur, and is from an inch to an inch and a half in length. This tail has a cavity, inclosed in which is a sharp needle-like sting, growing from the extreme point of the tail. The snake puts the end of the tail in the mouth, thus forming a hoop, and rolls forward until within striking distance, when it slips the tail from the mouth and strikes with considerable force tail foremost. The sting produces about the same effect as the sting of the adder. The horned snake is about three feet long when full grown, rather dark in color, and is oviparous. They are very scarce and seldom seen."

What is known as the horned snake in the West and Southwest is the *Farancia abacura*, of which the head and back are bluish-black above, and which has subquadrate red spots on the flanks. Its abdomen is rosy-red, with transverse or alternating bluish-black irregular spots. How or why it should have acquired the unenviable reputation it possesses, at present is unknown, for it is one of the most harmless and gentle of all snakes. That its tail ends in a horny tip is true, but the "bull-snake" of California, *Pityophis bellona*, has a similar horny tip, but neither the one nor the other ever uses it for defensive or offensive purposes. In some of the Southern States the grass lizard, *Opheosaurus ventralis*, is also called the horn snake.

Another serpent about which a curious superstition prevails is the "coach-whip snake," and lying at full length in the road it seems worthy of its popular name. To naturalists it is known as *Bascanium flagelliforme*. The anterior fourth of the body is a deep brownish-black color, which gradually becomes lighter until near the posterior part, where it is of a yellowish-gray. This coloration, in connection with a peculiar arrangement of the scales, gives it a very whip-like appearance, the dark part of the body being the handle, the lighter the lash. This reptile, in the South, has long been a terror to the colored population, and many are the stories related of how drunken and belated negroes have been found dead in the road, whipped to death by the coach-whip snake. Perhaps it would not be unfair to say that it is probable that this tradition was encouraged during ante-bellum days as a wholesome corrective to the night-prowling propensities of the slaves. This serpent is very graceful, and it may be imagined that if held, provoked, or irritated, it might, in its efforts to escape, switch fiercely with its long tail and body; but as for its being able to seize a person and whip him to death, the tradition must be consigned to limbo, with others of similar nature. From the somewhat fragile nature of the ligamentous attachments of the spinal vertebræ of the reptile, it is more likely that the snake would stand a better chance of breaking its back than of inflicting serious injury.

Of all the habitable regions of the globe, the empire of India is without doubt the one in which the greatest destruction of human life takes place from the bites of venomous serpents, and it may be interesting to briefly consider some of the well-known species which contribute to the fearful result. Sir Joseph Fayrer states that the average mortality from serpent-bite is fully twenty thousand annually, and in 1869, care was taken to obtain, officially, returns of cases, which showed that out of a population of 121,000,000, in an area embracing only one-half of the peninsula of Hindostan, the deaths were 11,416, or nearly one in ten thousand. These deaths were caused, as nearly as could be ascertained, as follows: *Cobra*, 2,690; *Krait* (*Bungarus ceruleus*), 359; other snakes 839; unknown snakes, 6,922; no details, 606; total, 11,416. The British government recognizing the importance of destroying venomous snakes, paid a bounty, in 1880, for the enormous number of 212,776, and in 1881, for 254,968.

Superior in venomous properties are the *Elapidæ*, of which several genera are common in India; *Najidæ*, or snakes with hoods, or dilatable hoods, or dilatable necks; and the *Elapidæ*, without hoods. *Najidæ* contains two genera, *Naja* and *Ophiophagus*, and in *Elapidæ* are *Bungarus*, *Xenurelaps*, and *Callophis*. The characteristics of the family are a cylindrical body, a rather short and tapering tail, and a lateral nostril. The poison-fang has a mark in its convexity indicating the groove, differing in this respect from the poisonous water-snakes, *Hydrophidæ*, in which it is quite open. At the head of the list should be placed the *Cobra*, or *Cobra di capello*, *Naja tripudians*, of which there are a number of well-recognized varieties, all of them possessing most deadly properties. The largest *Cobra* seen by Fayrer had attained a length of five feet eight inches, and measured six and one-fourth inches in circumference, and a fowl bitten by it perished in one minute. The color of the *Cobra* varies from dark olive or black, to pale chocolate or yellow, and the markings on the hood vary greatly in the different varieties. All of them possess the hood, and never bite without expanding it, and, unlike the rattlesnake, the body is not coiled, the lower two-thirds remaining upon the ground while the anterior third is raised, the head oscillating from side to side with wary caution in preparing to attack. They are good climbers and take readily to water, although essentially terrestrial in habits. *Ophiophagus elaps* is the only representation of its genus, and is probably even more formidable than the *Cobra*, as it attains a length of from twelve to fourteen feet. It has no hood and is exceedingly aggressive. The coloration varies greatly, but the general tint may be described as olive-green above, the scales edged with black, the trunk having on it numerous alternate black and white bands converging toward the head. To the Bengalese it is known

as the "shell breaker," and its habits are largely arboreal, although it takes to the water. Dr. Carter relates the following anecdote regarding its fierceness: "An intelligent Burman told me that a friend of his one day stumbled upon a nest of these serpents and immediately retreated, but the old female gave chase. The man fled with all speed over hill and dale, dingle and glade, and terror seemed to add wings to his flight, till reaching a small river he plunged in, hoping he had then escaped his fiery enemy; but lo! on reaching the opposite bank up reared the furious *Hamadryad*, its dilated eyes glistening with rage, ready to bury its fangs in his trembling body. In utter despair he bethought himself of his turban, and in a moment dashed it upon the serpent, which darted upon it like lightning, and for some moments wreaked its vengeance in furious bites; after which it returned quietly to its former haunts." This serpent, as its name implies, devours other snakes, but it doubtless also feeds upon birds and small animals.

The genus *Bungarus* contains two Indian species, *B. fasciatus* and *B. cæruleus*, known to the natives as *Kraits*, and these serpents, next to the *Cobra*, are probably the most destructive to human life in India. The coloration of *Bungarus* is uniform blackish-brown, the head being white in young individuals, although as in the other serpents there is some variation of tint. In *B. fasciatus* the triangular shape of the body and sharp dorsal ridge are especially noticeable. *Xenurelaps bungaroides*, the only known representative of its genus, resembles greatly the *Bungarus;* but little is known as to its habits.

The genus *Callophis* contains a number of species, but from their small size and diminutive fangs they are probably not so dangerous to human life as the other venomous serpents.

Belonging to the viperine serpents is the terribly venomous *Daboia russelli*, which is of a light chocolate color, with black white-edged rings, and which also shows many variations of tints. It is most justly dreaded, for with its long, movable fangs it produces deep mortal wounds. It is terrestrial in its habits, and lives upon small animals. Dr. Imlach states that it is not uncommon to find two fangs on both sides of the upper jaw.

There are a number of other genera of poisonous serpents in India, such as *Echis*, *Trimeresurus*, *Peltopelor*, *Halys*, and *Hypnale*, which resemble the North American *Crotalidæ* in having the ante-orbital pit, and are without rattles; but space will not admit of a consideration of their peculiarities.

The most interesting of all venomous serpents are probably the sea-snakes, which inhabit the estuaries and tidal streams, and are known to naturalists as the *Hydrophidæ*. They have a wide geographical distribution, being found in the Indian and Pacific Oceans from Madagascar to the Isthmus of Panama; Günther says they are most numerous in the Eastern Archipelago and in the seas between Southern China and North Australia. The sea-snakes vary greatly in form, some of them attaining a length of five feet; the body is elongated, and in some instances is short and thick, while in others it is very thick toward the tail and much attenuated near the neck, the head being minute in proportion to the size of the individual. The posterior part of the body and the tail are flattened and compressed vertically, like the tail of a fish, and with it they swim with extreme grace. The fangs and jaws of the sea-snakes are generally smaller than those of land-serpents, the venomous teeth having open grooves. That they are venomous is without doubt, as several instances are on record of persons losing their lives, and Fayrer found by actual experiment the dangerous nature of their venom. Belonging to this family are seven genera: *Platurus*, *Aipysurus*, *Disteira*, *Acalyptus*, *Hydrophis*, *Enhydrina*, and *Pelamis*, and of these the latter only is known to be found occasionally near the Isthmus of Panama. *Platurus* contains two species; *Hydrophis*, twenty-seven; *Enhydrina*, two; and *Pelamis*, one. The coloration of the sea-snakes varies greatly, one of the most beautiful being *Pelamis bicolor*, the back of which is slaty black, the belly orange. Another very beautiful species is *Hydrophis nigrocincta*, in which the ground color is fawn, the entire body being partly surrounded with lake-brown circles.

In the experiments reported by Fayrer as having been made by Dr. W. P. Stewart, at Pooree, British India, the virulence of the venom of the sea-snakes is abundantly proved.

Fayrer's experiments, which were made upon different sorts of animals, using different kinds of serpent-venom, led him to the following conclusions.

Snake-poison acts with most vigor on the warm-blooded animals; birds succumb very rapidly; a vigorous snake can destroy a fowl in a few seconds. The power of resistance is generally in relation to the size of the animal, though not altogether so; cats, for example, resist the influence of the poison almost as long as dogs three or four times their size. Cold-blooded animals also succumb to the poison, but less rapidly. Fish, non-venomous snakes, mollusca, all die. After death from cobra-poison the blood coagulates, but generally remains fluid after the bite of a viperine serpent.

With regard to treatment of snake-bites, Fayrer tried every reputed antidote and every plan of treatment, but without success, although he believes that ligature, excision, and general treatment seem to afford some chance. Much, however, needs still to be done in the way of experimentation.[3]

It would be foreign to the purpose of this article to give an account of all the venomous serpents of the world, but the names of a few may be added to swell the already formidable list.

In Europe the most dreaded serpent is the *Pelias berus*, common viper; in Australia the *Hoplocephalus curtus*, tiger-snake; in Africa the different species of *Clotho*, *Megæra*, etc.; in South America the different species of *Craspedocephalus*, the *Jaracacas* and *Fer de lance;* while in Costa Rica particularly is found a genus of venomous serpents known as *Teleuraspis*, which are allied to the *Crotalidæ*, but have no rattles. These snakes are arboreal in habit, and present no less than five color variations, the most beautiful of all being of a golden-yellow color. A peculiarity of the genus is the presence of a series of scales above the eye resembling small horns. It is said that these serpents, which are very venomous, lie at full length along the branches of trees, striking at the faces of passers-by. In Mexico a large *Elaps* and the various *Crotalidæ* are most justly feared.

The illustrations which accompany this article have been drawn with great care by Mr. John Ridgway, of the Bureau of Ethnology, United States National Museum, from certain cuts already shown in the various works on Serpents; in other instances they have been copied from life, and leave nothing to be desired in the way of drawings. The large colored plate of *Crotalus adamanteus* has been drawn from a fine specimen owned by the National Museum, and that of *Heloderma suspectum* is by Mr. A. Zeno Schindler, copied from a living reptile in the same institution. Acknowledgment is also made to the published works of many authors, the most prominent being those by Mitchell and Reichert, Fletcher, Cope, Garman, Fayrer, Halford, and others.

[1] With regard to the very poisonous qualities of the Heloderma saliva recent experiments by the writer would seem to indicate an extremely feeble toxic effect, at least so far as rabbits and fowls are concerned.

[2] It is to be regretted that a repetition of Lacerda's experiments with the permanganate by the writer has not given the results claimed by the distinguished Brazilian.

[3] A series of experiments are now being tried to verify what appears to be decided antidotal effects of Jaborandi to Crotalus venom, the writer having succeeded in saving rabbits which had received fourfold lethal doses of the poison. It has no antidotal effect, however, upon fowls.

Henry Crécy Yarrow.

RESECTION OF JOINTS.—In the strictest sense, the terms resection and excision as applied to joints are not synonymous. The former involves the primary idea of the removal of a section of a bone, especially of its shaft; the latter refers more particularly to the removal of the joint as such. As a joint is excised by the resection of the ends of the bones that compose it, the terms in

J. L. Ridgway del.

LINDNER EDDY & CLAUSS LITH N.Y.

DIAMOND RATTLE-SNAKE. (*CROTALUS ADAMANTEUS.*)

Plate XXVIII.

Heloderma Suspectum. (Gila Monster.)

J. Zeno Schindler ad nat del.

Lindner Eddy & Clauss. Lith. N.Y.